No. II.

Experiments relating to the change of Place in different kinds of Air through ſeveral interpoſing Subſtances. By Dr. JOSEPH PRIESTLEY.

ONE of the moſt extraordinary circumſtances that ever occurred in the courſe of my experiments is that of the vapour of water, or of mercury, changing places with any kind of air, in veſſels through which air could not be made to paſs without great force, ſo that for moſt purpoſes they might be conſidered as air-tight. Of this remarkable fact, and of all the circumſtances that led to the complete aſcertaining of it, I have given an account in my former publications. I had alſo obſerved that different kinds of air capable of forming a chemical union would do it through a bladder that was perfectly air-tight, that in this manner pure air was imbibed by the blood through the membrane of the lungs, while phlogiſton was tranſmitted into the air within them. Since that time I have extended and diverſified the experiments, and have obſerved that what was done by air and water, will be done by any two kinds of air, and whether they have an affinity to one another or not, that this takes place in circumſtances of which I was not at all apprized before, and ſuch as experimenters ought to be acquainted with, in order to prevent miſtakes of conſiderable conſequence.

Having procured earthen veſſels of a very cloſe texture, ſo as to be apparently impervious to air, containing about an ounce meaſure, I could fill them with any particular kind of air, and then place them inverted in a large glaſs jar containing a different kind of air. I then heated the ſmall earthen veſſels through the glaſs jar by means of a burning lens, and I never failed to find after

after the experiment, that the air within the earthen veſſel was the ſame with that which had been on the outſide of it, while that within it was mixed with that on the outſide; but in ſome caſes the mixture was a chemical one, forming a kind of air different from either of them, while at other times they were only diffuſed through one another. It will be neceſſary therefore to recite the circumſtances as I obſerved them, that future experimenters may give more attention to them, and endeavour to aſcertain the cauſe of this difference, which I have not been able to do.

I put one meaſure of dephlogiſticated air into the ſmall earthen veſſel in a large glaſs jar containing inflammable air, and after heating it about half an hour, found the quantity of inflammable air conſiderably diminiſhed, and the air within the earthen veſſel wholly inflammable, and increaſed in quantity one half.

I repeated the proceſs with inflammable air in the earthen veſſel, and dephlogiſticated air in the jar, and then found the dephlogiſticated air ſomething diminiſhed, and the quality of it inferior to what it had been before. The air in the earthen veſſel was wholly dephlogiſticated, hardly diſtinguiſhable from that in the glaſs veſſel. There was no fixed air in either of them.

In both theſe caſes the mixture of the two kinds of air in the glaſs jar was evidently a chemical one, the quantity being diminiſhed; but the air that had been tranſmitted through the earthen veſſel in the contrary direction had undergone no change, being the very ſame with that in the glaſs jar. Of the reaſon of this difference I cannot form any probable conjecture.

When the two kinds of air were ſeparated by a bladder, and no heat was applied, I ſometimes found that the tranſmiſſion had been made both ways, without any chemical union.

Having

Having filled a tanned bladder with dephlogiſticated air, and put it into a large jar of inflammable air, I examined them about a month afterwards and found in each of them a mixture of both the kinds of air, and in the ſame proportions. They both exploded alike; and with equal quantities of nitrous air occupied the ſpace of 1.6. In the bladder there was ſlight appearance of fixed air, but in the jar none at all.

Reverſing this experiment, by putting a bladder filled with inflammable air into a veſſel containing dephlogiſticated air, and letting them remain from the 12th of Dec. to the 5th of Feb. I found the dephlogiſticated air diminiſhed, and of inferior quality. The bladder was air-tight, but much ſhrunk. There was fixed air in them both, but more within the bladder. They both exploded with violence, but that in the jar ſeemingly leſs ſo than that in the bladder. With equal quantities of nitrous air the ſtandard of that in the jar was 1.1, and that in the bladder 1.3.

That the fixed air in the reſult of this proceſs did not come from the corruption of the bladder, was evident from the following experiment. On the 20th of June I put a bladder full of inflammable air into a jar containing 90 ounce meaſures of dephlogiſticated air, and on the 23d of the ſame month another bladder of inflammable air into a jar of the ſame air, and on the 15th of July I examined them both. The 90 ounce meaſures of dephlogiſticated air were reduced to 47, of the ſtandard of 0.6, whereas it had been of 0.16, and the bladder was ſound. In the other jar the bladder was almoſt diſſolved, and exceedingly offenſive, and there was hardly any appearance of fixed air; whereas in the jar in which the bladder was ſound there was a great quantity.

The moſt expeditious manner in which I found the two kinds of air to change places was, when a quantity of

of any kind of air was confined in an earthen tube closed at one end, while the open end ſtood in a baſon of water or mercury. After this I expoſed the cloſed end of the tube to a red heat, which I contrived to do by means of a hole purpoſely made in the grate of a ſmall furnace. In this caſe whatever kind of air was contained in the tube before the proceſs, it was in a very ſhort time of the ſame quality with that on the outſide, which, being in the fire, was ſomething worſe than the external air. It made no difference alſo whether the tubes were glazed or not; and yet that they were air-tight appeared from their containing only a certain portion of air after their proceſs, as well as before. There was always, however, ſome change in the quantity, but on what principle this change was made I could not ſatisfy myſelf.

Three and an half ounce meaſures of inflammable air treated in this manner came out two ounce meaſures, nearly common air, with nothing inflammable in it.

The ſame quantity of nitrous air was reduced to $2\frac{3}{4}$ ounce meaſures and to the ſame ſtate. A candle burned very well it. The ſame quantity of phlogiſticated air came out $2\frac{2}{3}$, of the ſame quality with the preceding; but the dephlogiſticated air was increaſed to 4 ounce meaſures, of a ſtandard a little better than the reſt.

In the preceding experiments the air was confined by water; but the reſult was the ſame with thoſe kinds of air that required to be confined by mercury.

Marine acid air treated in this manner was much increaſed, but came out very nearly common air. Vitriolic acid air was neither increaſed nor diminiſhed, but was not to be diſtinguiſhed from common air after the proceſs. Alkaline air alſo was unchanged in quantity, but in quality it was the ſame as the reſt.

In order to repeat my former experiment on the tranſmiſſion of ſteam in this eaſy proceſs, I filled one of theſe

tubes with water; and expoſing the top of it to the fire, I found after ſome time $2\frac{1}{2}$ ounce meaſures of air in it, of the ſame quality with the preceding.

All the preceding experiments having been made with the ſeveral kinds of air unmixed with any other, I was willing to try the effect of a mixture of dephlogiſticated and inflammable air, ſuch as explodes with great violence with the flame of a candle or an electric ſpark. In theſe circumſtances, however, this mixture did not explode at all, the quantity was unchanged, and the quality was, as before, nearly the ſame as that of common air.

To my great ſurpriſe, I found that this mixture of dephlogiſticated and inflammable air did not explode in a red hot gun barrel, a copper tube, or one of ſilver; and though the heat was applied ever ſo ſuddenly. When it was put into a flint glaſs tube, it was alſo heated without exploſion, but the tube became black, by the calx of lead uniting with the inflammable air; but in a tube of green glaſs, in the compoſition of which there is no calx of lead, the mixture exploded. Why it ſhould not explode in the earthen veſſel, the gun barrel, or the copper and ſilver tube, I am unable to ſay; but it is probably owing to the dephlogiſticated air in the mixture uniting with the metal, and forming a calx rather than with the inflammable air, with which it was mixed. In an experiment with the copper tube the quantity of the air came out twice as much as it was when put in. Mixed with an equal quantity of nitrous air, the ſtandard was 1.4, and it exploded like a mixture of common and inflammable air.

To diverſify this courſe of experiments, I put the different kinds of air into earthen retorts ſufficiently air-tight for any common purpoſes, and putting the open ends into baſons of water, I placed the bulbs near to a fire, where the heat was about that of boiling water, and noted the following reſults.

Fourteen

Fourteen and an half ounce meaſures of inflammable air having been expoſed in this manner a good part of a day, was reduced to $8\frac{1}{2}$ ounce meaſures, nearly in the ſame ſtate with common air, without any thing inflammable in it. But 10 ounce meaſures of inflammable air from ſpirit of wine was firſt increaſed to $10\frac{1}{2}$, of the ſtandard of 1.56, then to $12\frac{1}{2}$, of 1.37; and it was ſtill ſlightly inflammable.

Seven ounce meaſures of dephlogiſticated air was increaſed to 12, of the ſtandard of 1.9, and it was afterwards brought to 1.25 with an equal meaſure of nitrous air; ſo that it was in all reſpects atmoſpherical air.

Ten ounce meaſures of phlogiſticated air came out 11, of the ſtandard of 1.8. It was afterwards farther increaſed, and was finally of the ſtandard of 1.38.

In all the preceding caſes the change was produced by means of the fine pores in the earthen veſſel, but I found that in more time the ſame change would be made through a quantity of water in a glaſs retort. For four meaſures of inflammable air having been expoſed to heat in this manner, though it was not changed in its dimenſions, was become of the ſtandard of 1.5, and exploded like a mixture of inflammable and common air.

Inflammable air kept in glaſs jars ſtanding in water does not in general undergo any ſenſible change in many months, except that it preſently ſaturates itſelf with water, and thereby becomes heavier than when freſh made. But, to my great ſurpriſe, I found that, though a glaſs veſſel was perfectly air-tight, yet if it had been broken, and the pieces had been joined with paint, or cement, the air would in time be changed for the external air. At firſt I found that a jar of this kind of air had in it a conſiderable quantity of common air by the manner in which it exploded, and by its being diminiſhed by a mixture of nitrous air. But afterwards I found

the inflammable air which had been kept in a glaſs veſſel of this kind all the winter was of the ſtandard of 1.45, and had nothing ſenſibly inflammable in it. I had many reſults of the ſame kind; but in a glaſs veſſel which was only cracked, but was air-tight, the inflammable air was not changed; though when a ſolution of copper in the nitrous acid was put into it, there was an efflorescence from every part of the crack on the outſide, which ſhewed that it was not in all reſpects impervious.

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